THE FUTURE OF BIOPESTICIDES IN DESERT LOCUST MANAGEMENT

REPORT OF THE INTERNATIONAL WORKSHOP

HELD IN

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Documents:
The workshop documents are available on CD. The CD's as well as hardcopies of the report can de obtained from FAO/AGPP
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Acronyms and abbreviations

AGRHYMET	*Centre de formation et d'information en agro-hydro-météorologie* Centre for Training and information on Agrometeorology and Hydrology
APLC	Australian Plague Locust Commission
BCP	Biological Control Products SA (Pty) Ltd
CABI	CAB International
CERES-Locustox	Centre for Ecotoxicological Research in the Sahel
CFA	*Coopération financière d'Afrique*
CILSS	*Comité permanent Inter-états de Lutte contre la Sécheresse dans le Sahel*
	Permanent Interstate Committee for Drought Control in the Sahel
CLCPRO	*Commission de lutte contre le Criquet Pèlerin dans la Région Occidentale*
	Commission for controlling the Desert Locust in the Western Region
CNLAA/CNLA	*Centre National de Lutte Anti-acridienne* National Anti-locust Control Centre
CRC	Commission for controlling the Desert Locust in the Central Region
CSP	*Comité Sahélien des pesticides* Sahelian Pesticide Committee
DFID	Department for International Development (United Kingdom)
DGIS	Directorate General for International Cooperation (Netherlands Foreign Aid Agency)
DLCC	Desert Locust Control Commission (FAO)
EIQ	Environmental Impact Quotient
EMPRES	Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (FAO)
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographical Information System
ICIPE	International Centre for Insect Physiology and Ecology
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
INSAH	*Institut du Sahel* Sahelian Institute
IPR	Intellectual Property Rights
LUBILOSA	*Lutte Biologique contre les Locustes et Sauteriaux*
	Biological Control of Locusts and Grasshoppers
NGO	Non Governmental Organization
OIF	*Organisation internationale de la francophonie*
	International Organization of Francophonie
PAN	Phenylacetonitrile
PAN Africa	Pesticide Action Network-Africa
PEA	Pesticide Environmental Accounting Tool
PRG	Pesticide Referee Group (FAO)
PSA	Provisional Sales Authorisation
QUEST	Quality and Environmental Survey of Treatments (of locusts)
RAMSES	Reconnaissance and Monitoring System of the Environment of Schistocerca
SDC	Swiss Agency for Development and Cooperation
SWARMS	Schistocerca Warning and Management System
WB	World Bank

Table of contents

Acronyms and abbreviations iii
Recommendations 1
Background 3
Opening ceremony 3
Summary of Plenary Sessions 4
Session A 4
Paper 1. Review of the efficacy of *Metarhizium anisopliae* var. *acridum* against locusts and grasshoppers. Harold van der Valk, The Netherlands 4
Paper 2. Lessons learned from operational use of Metarhizium in Australia. Peter Spurgin, APLC, Australia 6
Session B 7
Paper 3. Costs and benefits of biopesticides: How to take secondary costs into account. Adrian Leach, Imperial College, United Kingdom 7
Paper 4. Ongoing initiatives to build the Green Muscle® supply chain: An industry perspective. Ken Neethling, BCP, South Africa 9
Paper 5. Licensing issues connected with *Metarhizium anisopliae* var. *acridum* (IMI330189). Joan Kelley, CABI, United Kingdom 12
Paper 6. Biopesticide Registration in CILSS member states. Amadou Diarra, CSP, Mali 13
Action plan 15
Annex I Action Plan the future of biopesticides in Desert Locust Management 18
Annex II List of participants 28

Recommendations

The workshop participants, having taken into consideration biopesticide trial results, workshop presentations and discussions, recommend that the authorities responsible for implementing the proposed programme should:

1. *implement the plan of action as quickly as possible to ensure the rapid integration of biopesticides into operational Desert Locust management, especially into preventive control campaigns.*

To meet this objective they further recommend:

a) research and development:

1. *to improve the current formulation of Green Muscle® in order to facilitate its use;*
2. *to study the association of Green Muscle® with PAN;*
3. *to verify the efficacy of biopesticides in the field, in operational conditions based on standard*

b) to ensure availability and quality of biopesticide

1. *to accelerate the procedure for biopesticide registration in all concerned countries (by focusing on environmental risks) and based on the procedures currently in effect;*
2. *to promote standards for preserving product quality, from production to application;*
3. *to clarify the procedures for allocating licenses to produce biopesticides;*

c) information training, coordination and promotion:

1. *to emphasize awareness, capacity-building and training for the all stakeholders involved in Desert Locust management nationally, regionally and internationally;*
2. *to develop strategies to bring biopesticides into Desert Locust control operations.*

THE WORKSHOP

Background

During the 2003-2005 Desert Locust campaigns, control teams applied some 13 million litres of mainly organophosphate pesticides to roughly 13 million hectares of land. Although no serious human or animal health incidents were reported, in this or the previous emergency, the cost of safety measures was considerable and the health and environmental damage caused by the pesticides was significant. Consequently, the Food and Agriculture Organization of the United Nations (FAO) with other aid agencies have been working with affected countries for 25 years to develop alternative control technologies including a biopesticide based on *Metarhizium*, a fungal disease of locusts and grasshoppers, and a hormone PAN (phenylacetonitrile) that affects gregarization behaviour. Both products were developed specifically for Desert Locust management.

The workshop was held in Saly, Senegal from 12-15 February 2007 under the distinguished patronage of Madame Viviane Wade, First Lady of Senegal and President of the foundation, 'Agir pour l'éducation et la Santé'. It was convened as part of the FAO EMPRES programme (Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases), which is strengthening preventive control capacities in affected countries. The joint sponsors were FAO, the International Fund for Agricultural Development (IFAD), the International Organization of Francophonie (OIF), and the World Bank (WB).

The workshop, organized under the aegis of the Orthopterists' Society, brought together 66 participants, including sponsors, scientists, manufacturers and staff from Locust Control Organizations to determine

1. what role Metarhizium and PAN should play in Desert Locust management;
2. key actions required to integrate biopesticides into operational campaigns.

Opening ceremony

The Mayor of Saly, as host of the workshop, welcomed the Patron, Madame Viviane Wade, sponsors' representatives, and participants to Saly. The opening ceremony chaired by Madame Wade was addressed successively by Mr Amadou Diarra, Workshop Chairman, by M. Amadou Ouattara, Representative of FAO to Senegal by Mr Michel Lecoq, President of the Orthopterists' Society, by Madame Mame Fatim Gueye, of l'Organisation internationale de la Francophonie and by M. Tall, Directeur de Cabinet du Ministre de l'Environnement et de La Protection de la Nature who, in turn, welcomed the initiative to hold the Workshop and wished participants every success in their efforts to define an appropriate strategy for integrating biopesticides into Desert Locust Management.

In her opening address, Madame Viviane Wade, emphasizing the need to find effective and sustainable solutions that prevent locust plagues intermittently attacking African countries already severely affected by poverty, welcomed the workshop, the objectives of which were so perfectly attuned to achieving this goal.

The content and timetable of the workshop were endorsed by participants at a brief technical session held immediately before the opening ceremony. The plenary sessions provided participants with the necessary background for developing action plans for adding biopesticides into the Desert Locust plague prevention strategy. Session A reviewed lessons learned during field trials and in operational use of the biopesticides Green Muscle® and Green Guard® and session B considered practical and regulatory steps required to develop supplies for operational use. The papers presented and the discussions are reported more fully than normally as they included valuable information for developing action plans.

Participants then worked in three parallel sessions developing draft action plans for 2007 and 2008 to enable biopesticides to be integrated into operational plague prevention campaigns. Group 1 considered additional research and development priorities, Group 2 examined the supply chain and regulatory processes and Group 3 identified information, coordination, training and awareness programmes required nationally, regionally and internationally by involved partners. The resultant action plan is at Annex 1.

The list of participants and workshop moderators is at Annex 2.

Summary of Plenary Sessions

The plenary sessions considered lessons learned on biopesticides, how to develop their supply for operational use and methods of integrating them into the plague prevention strategy. The six papers presented and the discussions on them are summarized below.

Session A

Paper 1. Review of the efficacy of* Metarhizium anisopliae *var.* acridum *against locusts and grasshoppers. Harold van der Valk, The Netherlands

Mr. Van der Valk had three objectives in reviewing trials with *M. anisopliae* var. *acridum* against different species of locusts and grasshoppers:

1. to evaluate product efficacy against Desert Locusts;
2. to extrapolate data from trials on other species, whenever possible, to the Desert locust;
3. to identify gaps in knowledge

He had sixty field studies with oil based formulations of *M anisopliae* var. *acridum* isolates available for review, of which 41 had been carried out in Africa against the Desert Locust, Migratory Locust and Senegalese Grasshopper, 16 in Asia and Australia and 3 in Latin America. Eight studies using the isolate IMI330189 (Green Muscle®) against the Desert Locust, described 25 individual treatments. Data on the following isolates were available:

Isolate	Trade Name	Treatments
IMI 330189	Green Muscle®	31
F I985	Green Guard®	16
I 91609		8
Other		10

Criteria were selected to evaluate trial design and implementation (9 criteria) and reporting (15 criteria). They were based on guidelines for trials from three sources and were not stringent:

1. FAO Desert Locust Guidelines
2. FAO/PRG reports
3. LUBILOSA insect pathology manual.

Trial and report quality were found to be suboptimal. None of the trials satisfied all criteria. Only 5 out of 60 trials satisfied ≥ 80% of criteria. Nineteen trials did not satisfy or did not report on ≥ 50% of criteria. As a result, seven trials were excluded from the review. Critical shortcomings of the reports found were:

1. Spore viability not determined/reported (54%)
2. Dose rate not measured/reported (85%)
3. Insufficient reporting on environmental conditions, application details, cage assessment methodology
4. Reporting of study averages rather than data of individual treatments/plots.

Of the eight efficacy trials carried out in Algeria, Mauritania, Niger, and Sudan, only six were sufficiently well reported to be reviewed. This provided 13 treatments from 3 small scale and 3 medium to large scale trials against Desert locust using IMI330189 (Green Muscle®). Dose rates tested ranged from 2.5 x 10^{12} to 5.9 x 10^{12} spores/ha, which corresponds to 50-118 g/ha. Efficacy assessment methodologies used included:

1. Caging of treated insects and mortality assessment (12 treatments)
2. Assessment of changes in field population levels (8 treatments)
3. Both methods in parallel (7 treatments).

The majority of treatments resulted in adequate (>90%) Desert locust mortality 6 to 14 days after application. In 11 treatments, this was achieved in either cage or field assessments, and in one treatment, in both cage and field assessments. One trial was clearly unsatisfactory (Niger, 2003), possibly, due to low spore viability and/or low temperatures.

The trials failed to identify clearly the dose-response effect. No significant decrease in speed of action or efficacy was found with lower dose rates so that 50 g/ha appeared just as effective as 100 – 120 g/ha. A definite conclusion is precluded owing to the relatively limited data set and the variability of trial conditions.

Temperature plays the most significant role among factors affecting the performance of Metarhizium, The optimum temperature range of the pathogen (27-29ºC) is much lower than the Desert locust (41-43ºC) (Blandford & Klass, 2004), which might result in its suboptimal efficacy at very high or very low temperatures.

Based on the data reviewed, the presently recommended dose rate for Desert Locust is 2.5 x 10^{12} spores/ha or 50 g/ha falls within a low range of available studies for this species. Comparison with other species confirms likelihood of effectiveness at this rate, but does not suggest further dose reduction is feasible at present.

The effects of the three modes of exposure differ between Desert Locusts and less mobile grasshoppers:

1. Direct deposition of spray droplets is important for Desert Locusts, as they are likely to move out of sprayed plots and minimise secondary pickup. High vegetation density, however, can shield them from spray deposit.
2. Two factors reduce the importance of secondary pick-up from vegetation, Desert Locust mobility and the short duration of spore persistence in their habitat. Consequently, secondary pick-up from vegetation is less effective than for some grasshopper species (e.g. Rice Grasshopper, Benin) where the contribution of secondary pick-up to the total mortality was higher than direct contact with spray droplets. Larger plot sizes for future trials would increase the time hoppers remain in the sprayed area. Swarm treatments, however, may be ineffective due to their rapid exit from sprayed sites.
3. Horizontal transmission from infected cadavers is not relevant for the Desert locust.

The reviewer concluded that the existing (although not very robust) data set from trials with Desert Locust and with other species appears to support the effectiveness of the dose rate of 2.5 x 10^{12} spores/ha, (50 g/ha). Further field efficacy data for Desert locust need to be collected to show the robustness of the rate under a variety environmental conditions. The so-called "unsuccessful" treatments may in fact provide very useful data on limiting environments. Improving the quality of reports is a key issue for the future.

Mr van der Valk noted that the hormone PAN (phenylacetonitrile) has two possible uses in locust control:

1. PAN alone (disrupts gregarization, reduces feeding and marching, and increases mortality due to predation).
2. PAN + insecticide or Metarhizium (reduces the dose required as a "synergist", possibly by affecting the immune system).

He noted that reports to date of trials with PAN in Sudan provided insufficient information to assess trial quality or the validity of results and so he omitted them from his detailed presentation.

In the answers to questions, the reviewer underlined the importance of predation when assessing mortality of the Desert locust treated with *Metarhizium*. He noted difficulties of assessing causes of mortality properly, among which is separating predation, if deemed necessary, from the direct mortality from the pathogen. He reiterated that the present data did not support a lower dose rate than 50 g/ha against the Desert Locust, but agreed that if a more effective formulations could be developed, the dose rate might be further reduced. The main constraint from the environmental point of view is the effective temperature range. The effect of UV on efficacy may be important and should be included in future assessments along with other factors such as temperature and predation.

Paper 2. Lessons learned from operational use of* Metarhizium *in Australia. Peter Spurgin, APLC, Australia

Mr Spurgin described the role of the Australian Plague Locust Commission (APLC) in preventing swarms invading major cropping areas. Currently, the APLC uses three acridicides: fenitrothion, fipronil (Adonis 3UL) and Green Guard® which is similar to but based on a different isolate (FI-985) of *Metarhizium anisopliae* var. *acridum* from Green Muscle® . Green Guard® development in the 1990s was driven by a trend towards organic livestock production in remote locust source area where a total of 10 million hectares is now certified as organic. Other concerns were protecting the population and the environment especially waterways from agricultural chemicals.

The Plague Locust (*Chortoicetes terminifera*) control strategy is based on preventive treatments against successive generations of nymphal bands to reduce the threat of adults migrating into cropping areas. The early intervention strategy produced a 1:20 return in a cost benefit study recently completed by the Australian Bureau of Agricultural and Resource Economics. Green Guard® was registered in 2004. Since 2000, the APLC successfully treated 73 000 ha with it, which corresponds to about 200 hopper bands with an average area of 365 ha each. Typically, an efficacy of 80% and higher is achieved in 10 to 14 days after application of 25 g/ha dose rate with daily T>35ºC and night T>16ºC. About 10% of APLC treatments use Green Guard® to protect organic rangelands, ecologically sensitive areas, wetlands and waterways.

Fipronil applied in widely spaced barriers is cheaper to use and has a higher work rate than fenitrothion and Green Guard that require blanket applications

Product	Work-rate	Cost /ha $US
Fipronil	25 minutes / 1000 ha	2.60
Fenitrothion	45 minutes / 300 ha	4.60
Green Guard	45 minutes / 300 ha	11.50

The main problem with applying Green Guard® is that the spores settle into a sludge after vibration caused by transportation. The problem was solved by field mixing. Other concerns include the use in dense vegetation and low temperatures during spring when poor kills (mortality 50-70%) may take up 30 days.

In answers to questions, Mr Spurgin said that no spore germination occurred in the product sludge. He noted that “Green Teams” were created to ensure that Green Guard® was applied by specialists. He confirmed that Australian Plague Locust habitats were in general, similar to those found in the Sahel. He agreed that the longer kill time was an important awareness issue for farmers which had to be explained clearly. He added that in general, APLC does not use Green Guard® for crop protection or for treatment of small (under 100 ha) targets. For farmers, an advantage of Green Guard, is that it requires no withholding period when sprayed over livestock. Whilst Green Guard® uses the same spraying equipment as the two chemical pesticides, APLC have to use aircraft free from pesticide contamination in organic areas to prevent land being contaminated with pesticide residues.

Session B

Papers three to six were presented in this session.

Paper 3. Costs and benefits of biopesticides: How to take secondary costs into account. Adrian Leach, Imperial College, United Kingdom

Mr Leach described an approach being taken to estimate the total direct and indirect costs of using biopesticides as opposed to chemical pesticides for locust control campaigns using Senegal north of the Gambia in 1993-1994 and 2004 to test and validate the methodology.

He outlined costs to be used, the sources of such data and the calculations to be done within the study. Briefly, **direct costs** include the cost of pesticides ready for application, application equipment, labour for distribution and application plus any administrative costs with organizing the acquisition and application of pesticides for locust control. **Indirect costs or externalities** arise as a consequence of using pesticides. These costs are frequently unquantified and include pollution of soil and water, the poisoning of applicators, bystanders, or consumers; detrimental effects on non-target organisms such as birds, livestock, bees; the cost of disposal of obsolete stocks of pesticides and empty containers.

Calculating the benefits of using a biopesticide is a 3-step process:

1. Determine the direct costs of current pesticide use
2. Determine the direct costs of future methods of pest management (e.g. biopesticides)
3. Compare direct and external costs of each to determine cost effectiveness.

Mr Leach then outlined the procedures for comparing current costs of pesticide use with future pesticide and biopesticide use in northern Senegal as requested by FAO.

1. Calculate total external costs during an outbreak in N. Senegal
2. Calculate environmental impact quotients (EIQs) of each pesticide used
3. Combine the information from steps 1 & 2 into a single framework called the Pesticide Environmental Accounting Tool (PEA)
4. PEA output 1 is the secondary cost of a single application per hectare for each pesticide of interest
5. PEA output 2 is the average secondary cost per hectare of all pesticides currently used per application (weighted by area applied)
6. PEA output 3 is the average secondary cost per hectare of all future pesticides and biopesticides used per application (weighted by the expected application area)
7. Use historical data of control operations from specific outbreaks to calculate the spatial distribution of externalities of pesticides currently used and compare this against the secondary costs of a future pesticide plus biopesticide profile for the same outbreak. A comparison of current versus future secondary costs can then be made.

Spatial aspects of a campaign form an important part of the approach as reinvaded zones may require repeated treatments and the sensitivity of environments varies spatially. Data from the 1993-1994 and 2004 Desert Locust campaigns in Senegal will be “virtual” testing grounds where internal and external costs can be calculated using current pesticides profiles against those of the future that include biopesticide(s). The model thus becomes a tool where one can compare direct and indirect costs to make pricing suggestions or policy decisions.

Mr Leach stressed that model outputs shown were based on some proxy data and best guesses in order to demonstrate how components interact. No conclusions should be drawn from the results shown in his presentation. For example, instead of quantities of pesticide applied per hectare he used weekly gregarious adult and hoppers reports in Senegal as a proxy for where pesticide applications had been made (FAO Locust Watch ECLO Mapper web-site).

The model has four sections, the most important being the estimation of external costs of pesticide/ha for each application.

1. External costs of pesticides → EIQ with costs → summary of individual EIQs
2. Areas sprayed weekly 1993-1994 → cumulative area sprayed → pesticide externalities
3. Areas sprayed weekly in 2004 campaign → cumulative area sprayed → pesticide externalities
4. Total pesticide costs for Senegal during the two outbreaks → total future costs of pesticides during the two outbreaks → summary and graphics

Questions/Comments and responses

Q1. Can the model compare any kind of pesticide? Can it be used to choose chemical pesticides?

A1. Yes, the Environmental Impact Quotient system developed by Kovach *et al* in 1992 was developed to compare the EI of any pesticide for which the basic toxicology data is available. The EIQ system uses standard data necessary for the registration of any pesticide and is easily accessed by the internet at resources like the EXTOXNET web site. The original system, which takes into account formulation concentration and application rates, was designed specifically to assist in the identification of pesticide applications that were more appropriate for Integrated Pest Management programmes.

Q2. From experience evaluating ecological services, it is not very convincing to value the ecological services[1] . Some externalities we discuss but cannot quantify. How will these unquantifiable externalities feed into the model? How are these decisions used politically?

A2. Yes, this is difficult. In 2001, Pretty *et al* took data from previous studies and used a standardised methodology for estimating pesticide externalities in the UK, Germany and USA. The costs were broken down into six classes which included, for example, costs of "Pesticides in sources of drinking water", "Acute effects of pesticides to human health" and "Biodiversity/wildlife losses" The costs in their methodology were, wherever possible, remediation based e.g. the cost of returning a pesticide poisoned person to health; the cost of removing pesticides from drinking water; and, with respect to ecological services aspects, how much would it cost to restore pesticide affected habitats to their previous condition. We then integrated the Pretty *et al* "ecological services" costs and distributed these across the Kovach *et al* classes for ecological services such as "Aquatic effects", and effects on "Birds", "Bees" and "Non-target arthropods". The PEA system does not preclude subjective judgements but, as I said at the end of my presentation, these judgements are, we hope, transparent and handle the available data in a logical and consistent way. The challenge for Professor Waibel will be to estimate pesticide externalities in Senegal in such a way that they can be used in the PEA whilst satisfying the majority of interested stakeholders. The former is relatively simple and the second rather more difficult.

Q3. Externalities are a whole range: from pollution to poisoning. When it comes to putting a cost on poisoning someone, how do you do it? You work with the data you have. Perhaps the bigger difficulty will be after you DO have Senegalese data. The law here is different from Europe, which is different from the U.S. with respect to remediation. Considering tourism as a proxy for the cost of environmental damage, interesting things can be investigated, but the character of tourism is very different from one place to another, such as Europe. The big challenge will be to know what to do with the data when you have them.

A3. The externalities that Pretty *et al.* 2001 used were based on two types of estimates:

a. Those that were relatively easy to quantify such as bee losses and the costs associated with reduction in pollination and honey production

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[1] **Ecological Services** also called **Ecosystem services** are processes by which the natural environment produces resources useful to people, akin to economic services. They include: provision of clean water and air; pollination of crops; mitigation of environmental hazards; pest and disease control; aesthetic, cultural and ethical values associated with biodiversity

b. Remediation, i.e. how much does it cost to return polluted environments, drinking water or poisoned persons back to their previous condition?

We recognise that data for this may be much sparser in Senegal than it was for Germany, UK and USA and, consequently, we may be forced to rely on proxy variables and best guesses informed by activities in other countries. For example, we know that the Pesticide Action Network in Morocco is developing a pesticide poisoning data base that will be much more relevant and therefore applicable to Senegal than similar data from the EU or USA. As a first step in working toward externality valuation, the model provides a check list of data required to make the valuation and, thus, helps to identify information gaps in which the system is applied.

Q4. What are the benefits of biopesticides with respect to other pesticides? How do we convince potential users to use them?

A4. The model calculates the monetary value of pesticide externalities and assumes that the external costs of Green Muscle® in Senegal are zero. So, if a biopesticide is used to replace a pesticide such as chlorpyriphos and malathion that had quantifiable detrimental impacts on environmental and human health then these translate directly into the benefits of the technology replacing it e.g. *Metarhizium*

Q5. It is difficult to get data. One must take into account that most applicators are not always applying products properly. There is a high pesticide use in the NW region of Senegal between Louga and St. Louis where according to the soil properties there is often egg laying. Often several applications are made as in 1993-1994 and in 2004. It is thus very difficult to gather the data for Senegal. One must put much effort to get reliable results.

A5. Yes, we know that some data will be varied and contain inherent variability and we can include such variability in the model by using stochastic (probability based) techniques to describes the deviation in, say, application rates from those recommended and other important variables where fixed (deterministic) values, that declare that we are 100% certain about a value, are not appropriate. As regards the NW corner of Senegal being a corridor. Yes, it certainly appears so. We relied on this method of estimating pesticide applications in the absence of readily available local data in the last few weeks leading up to this conference. We hope to get local, spatially-referenced historical data of pesticide use when the contract starts in earnest.

Q6. Will you concentrate on collecting externality data on those factors that can be most easily quantified, such as disposal costs of synthetic pesticides?

A6. Yes, it will be very tempting to grab the most available data first and these will be a starting point but we will need to locate and start analyzing some of the more cryptic data soon in order that we can allow ourselves time to consider how to extract and handle it.

Paper 4. Ongoing initiatives to build the Green Muscle® supply chain: An industry perspective. Ken Neethling, BCP, South Africa

Mr Neethling explained that Biological Control Products SA (Pty) Ltd, (BCP) has been supplying Green Muscle® since 1999 and that this biopesticide developed during the LUBILOSA project had development costs exceeding GBP11 million. It is manufactured under a licence that imposes strict quality control standards. He summarized current requirements, opportunities and constraints for manufacturers in a series of questions and answers.

Who are our customers? The environment (global sustainability), international donor community, EMPRES, CNLAA, CABI, CILSS, IITA, NGOs, and countries affected by locusts.

What do the customers want? Parity with chemical prices, short lead times, sufficient supply. In addition they want: irregular off-take when outbreaks occur, a robust product (easy to store, mix, apply), low environmental impact.

What is industry's perspective? (Speaking for BCP) a. Large volumes (to achieve economies of scale); price comes down dramatically when quantity is increased. b. Payment received soon after manufacturing costs have been incurred. Consistent, regular off-take; forecasts and feedback from customers.

What does Supplier Capacity and Reliability mean? Capacity means the resources, financial and backing, infrastructure for storage, research and quality control.

Reliability means having a history in supplying a product and the ability to meet future demand.

BCP's can produce 4.5 tons of active ingredient annually which is enough to treat 100,000 ha. The 2400m^2 factory has provision for expansion. BCP can scale up production in response to demand. There is a quality control laboratory free from contamination. BCP can determine shelf life, viability, concentration, and stability of products. There is an entomology facility where tests for efficacy against target organisms can be done. BCP produces 30 products; Green Muscle is just one of them. Reliability: BCP has met all orders for trial material. It is committed to meeting future orders. A product must be commercially sustainable. Reasonable notice is required on future volume expectations. BCP has a highly trained staff, documented standard operating procedures and production track record. Additional information is available at www.biocontrol.co.za.

Mr Neethling then described the current distribution process which takes more than 7 weeks from start to delivery and listed constraints in parentheses and some solutions in a table to guide discussions:

1. Outbreak detected. (no advanced notification)
2. Invitation to tender. (time consuming)
3. Tender submitted
4. Order placed (assuming stock availability)
5. Product formulated and dispatched. (<1 week to formulate and dispatch)
6. Transport by air. (unavoidable delays possible in international transit)
7. Product cleared at port of entry, requires local representative
8. Transported by road to treatment site. (arduous and long)

Problems	Solutions
Distribution issues	Use direct courier (<1% of total application costs
Lead time for delivery to point of use	Minimize tender process and give advanced warning on orders
Reactive response	Introduce preventative strategies with low environmental impact
Field stability	BCP to improve shelf life and stability of Green Muscle®
Price	Volume dependant. Thus: • increase regular use • increase range of use
Availability	Stockpile active ingredient in a cold storage "bank" ahead of demand
Capacity	Capital investment is required to increase capacity in response to demand. Work with other suppliers.

Questions/Comments and responses

Q1. Is there any work being done to increase the virulence and the temperature performance curve?

A1. Regarding virulence and low temperatures, we are dealing with a living organism. There is an inherent temperature range.

Q2. Would it be economically viable to develop a low-temperature isolate?

A2. Some strains have different temperature preference. We must not grow isolates that either survive or grow above 37C because there are concerns about the potential for infection at mammalian temperatures. Because temperature range is an inherent property, we can't do much about it. Developing a low-temperature isolate would involve a lot of toxicology, ecotoxicology and field trials that would be costly. BCP has 30 products so we have been through the process many times. It can be done, but it must be done according to customer demand

Q3. Regarding the short advance notice for delivery, there have been a few occasions when we (FAO) asked for the product within a week. The chemical industry generally can't do it, but BCP has. Trial opportunities are special and fleeting. Swift delivery of the product is required, and this task must be integrated with many other activities over a short period. BCP *has done an extraordinary job. The transport problems that were mentioned can be overcome.*

A3. Thank you for the complement on our delivery performance

Q4. In your presentation, you said that BCP has a capacity of 4.5 tons of spores. Over how long a period?

A4. Our annual capacity is 4.5 tons of spores.

Q5. What is the average cost of Green Muscle®?

A5. Price is volume-dependent. Currently, it is $18/ha for 400L trial at 50g/ha. In Sudan, larger quantities have been used. The price comes down significantly with increased volume. Price is a cost-plus basis. We consider Green Muscle® as a price-sensitive product, meaning that demand is very sensitive to price. Green Muscle's price needs to carry the cost of production. Other products carry our profit.

Q6 Regarding formulation. There is a sedimentation problem after a certain period storage under refrigeration. With respect to this formulation, what are the good conditions to reduce this tendency, for example temperature?

A6 Regarding the sedimentation problem, it is like asking, "How long is a piece of string?" The answer depends upon the storage conditions. Cold storage slows down sedimentation by increasing the viscosity. The best solution is ordering quickly near the time it is needed.[2]

Q7 For Green Muscle® tests in Sudan, we started with 100g/ha dropped to 50g/ha and tested 25g/ha. Are there other means of improving efficacy such as choosing times of application? What does this mean for the industry?

A7 PAN we are looking at the possibility and looking at temperature profiles, optimal times for application.

Q8 Specialized tools have a downside as well as upside. Green Muscle® has a narrow host range. What is its current status in terms of tenders?

A8 Regarding the question on blurred market vision. We need to keep our focus. Green Guard® has a willing partner, a regula r 10% off-take, and champions assisting their cause. Our situation is less favourable.

Q9 The speaker gives us a vision of how the market needs to adapt. My fear is that it is very difficult to forecast Desert Locust populations, yet this is perhaps the key to predicting demand for a biopesticide. How do we find a mechanism to solve this problem for anticipating demand? Compare the African situation to the Australian situation. Are specialized teams necessary for good application?

Q9 Predicting demand is a key issue. Buffer stocks may help address this problem. Regarding specialized teams, there are costs to having specialized teams. The best situation would be using the same teams for both synthetics and biopesticides. In most African situations, no opportunities exist for applying Green Muscle® to protect the organic accreditation of a grower, as is the case with Green Guard® in Australia. Therefore, there is less need to keep equipment uniquely reserved for biopesticides.

Q10 BCP has proposed to improve formulation. What are the plans? Genetics? Formulation? Other tactics?

Q10 CABI developed a formulation. It is old an there is room for improvement. Regarding improving Green Muscle® through genetic and formulation modification. Genetic modification is a risky route to pursue. There are groups opposed to genetic

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[2] *Note from the editor*: The answer is not correct. Spores in the formulated product sediment during transport in the field and are difficult to resuspend. One solution is to resuspend them before spraying, another is to improve the formulation. The latter is part of the plan of actions.

modification, although some are pro. There is potential to modify temperature sensitivity, but it is a very difficult thing to manage. We do not suggest delving into this.

Paper 5. Licensing issues connected with Metarhizium anisopliae var. acridum (IMI330189). Joan Kelley, CABI, United Kingdom

Ms Kelley explained that CAB International (CABI) is an intergovernmental not-for-profit organization owned by 45 member countries many of which have problems with locusts or grasshoppers. CABI also has a long-standing connection with Green Muscle® as it was the implementing agency for the LUBILOSA project and one of the research and development partners that developed this biopesticide.

An Intellectual Property Rights (IPR) agreement was signed in 2001 between SDC (Switzerland), DFID (UK), DGIS (the Netherlands) and CABI in which the three donors ceded all IPR from the LUBILOSA project to CABI. This provided a single entity that could license Green Muscle®. CABI's obligations were to establish the LUBILOSA Trust; to use the IPR (i.e. licences), to "underpin" the quality of the product, and "to negotiate the maximum level of licence fees and royalties reasonably available for the benefit of the fund."

Green Muscle® Licences include clauses that require a reasonable price relative to local market for the product, reasonable availability with the sponsor's core countries of interest, good commercial practice regarding transfer of public sector technology to private sector. Currently, there is one formal licensee, BCP in South Africa. BCP pays a licence fee up-front and splits the royalty fees between LUBILOSA Trust and a local trust in South Africa.

Licences are restricted to specific countries and territories. Currently, there is no licensed supplier in West Africa but licensing SenBiotech in Senegal is in progress.

CABI, SDC (Switzerland), DFID (UK), DGIS (the Netherlands) established the LUBILOSA Trust in 2001. CABI was appointed as Trustee and pays monies from licences, royalty and downstream products worldwide into the Trust. The Trust assures access of benefit sharing under the terms of the Convention on Biodiversity and its purpose is "to promote and support biopesticide research, development, and use in Africa". Interested parties may apply for grants for a narrow range of topics and activities.

- Pathogen, identification, characterisation and storage;
- Regional workshops;
- Information and pathogen transfer;
- Purchase and distribution of key manuals and text books.

The Trust has a Disbursement Committee and the unanimous written consent of all members of the committee (i.e. the three donors) is required before CABI can release funds. None has been disbursed yet.

In conclusion, Ms Kelley noted that:

- Producers and FAO would like territory based licences to be reviewed.
- Oversight of product quality needs clarification and procedures and resource should be put in place
- LUBILOSA Trust disbursement process needs to be simplified
- The mandate of this meeting to clarify and streamline agreements would hasten changes

Questions/Comments and responses

Q1 From a producer's perspective, there is a need that CABI could fulfil, for instance particle size monitoring. If we could have two-way knowledge exchange, it would help producers. There is the possibility of technical support from people who have years of experience.

A1 CABI has been given many responsibilities, but few resources to carry them out – quality control for example. We need more cooperation with the donors to simplify the quality monitoring system. Particle size monitoring is done at Imperial College.

Q2 What is the status of the SenBiotech licence?

A2 Regarding the SenBiotech dossier, all we currently require is access to the product to run it through the quality assurance system. There is a problem with registration as Green Muscle® by SenBiotech, however, because another company has a registration of Green Muscle® in West Africa but it will soon expire.

Q3 How can registration be streamlined and what do you think about CABI's role in the registration process?

A3 The next speaker will describe the registration process in CILSS countries. With respect to registration in general, CABI issues licences for Green Muscle®, which includes: handing over to the licensee: the strain, a full ecotoxicology package, formulation, toxicology dossier, the right to use the trademark and quality control support. There was a proposal submitted to donors by CABI and IITA to look at stewardship and do country by country licensing, but it was not awarded.

Q4 Is the Australian isolate (Green Guard®) also from CABI?

A4 CABI do not license Green Guard®, which is based on a different isolate of *Metarhizium*.

Paper 6. Biopesticide Registration in CILSS member states. Amadou Diarra, CSP, Mali

Mr Diarra explained that CILSS is an intergovernmental organization with nine member countries stretching from Cape Verde to Chad whose populations currently total 54.5 million and are predicted to reach 80 million by 2015. The land area of CILSS states is 5.3 million km^2 of which 71% is arable land producing a gross cereal output of 9.3 million tons annually.

The mandate of CILSS' Institut du Sahel (INSAH) at Bamako, Mali includes the registration of pesticides through the Pesticide Committee for the Sahel (CSP) and Mr Diarra outlined the factors that led to a common registration process for Member States from 1992 that was revised in 1999. An awareness of a need for environmental safeguards arose from:

1. large-scale application of pesticides to control Desert Locusts and grasshopper outbreaks following drought breaking rains in 1985;
2. introducing integrated pest management projects to combat crop pests in the Sahel;.
3. a weak registration process that allowed free circulation of highly dangerous pesticides

The requirements for registering a product under the CILSS Common Regulation for the Registration of pesticides (1992, 1999) are:

1. efficacy
2. required to be non-harmful for humans and non-target fauna
3. techniques must exist to determine composition and impurities
4. required to be non-phytotoxic
5. required to be safe for the environment
6. maximum safe residue levels must have been determined.

The Registration process has 3 phases:

1. pre-registration for experimental purposes is handled at national level;
2. registration is a regional responsibility entrusted to the Pesticide Committee for the Sahel (CSP) of which Mr Diarra is the Permanent Secretary
3. post-registration audit and monitoring is a national responsibility.

The definition of a biopesticide in the CILSS states is:

- a biological control agent formulated and applied in the same way as a chemical pesticide and where the active ingredient is a micro-organism (fungus, bacterium, virus and protozoan)

Mr Diarra emphasized that this definition excludes the following control agents from biopesticide registration in CILSS states:

- nematodes, biochemicals, pheromones, hormones, growth regulators, genetically modified organisms, plant extracts.

Mr Diarra then described the nine dossiers to be presented to CSP for biopesticide registration i.e. products containing a biological control agent as defined above. Nine dossiers on the following topics are required:

1. an application for the formulated product, duly completed, signed and dated by the applicant;
2. a summary of dossiers presented;
3. a dossier on the identity of the formulated product;
4. a dossier on the identification of the biological agent;
5. a dossier on the product's biological efficacy
6. a toxicological dossier
7. an environmental dossier
8. a packaging and labelling dossier
9. a sample of the formulated product.

Mr Diarra then provided detailed requirements for each dossier (not reported here) that are available in English French and Portuguese on the INSAH web site.

A Provisional Sales Authorisation (PSA) valid for three years was granted to Green Muscle® for Desert Locust control in June 2001, which was renewed in June 2004. A definitive registration MUST be submitted before June 2007.

CSP made the following recommendations to Member States during the 2003-2005 Desert Locust emergency:

1. use more biopesticides and growth regulators;
2. strengthen the capacity (personnel and equipment) for this use;
3. engage national toxicological institutes to monitor human health and the environment.

Mr Diarra's concluding remarks to participants were that for CILSS countries:

dossier details and the registration process for biopesticides are available at the CSP Secretariat;
countries should promote biopesticides for Desert Locust control;
INSAH is ready to collaborate in locust control programmes;
INSAH can be contacted by e.mail csp@insah.org and administration@insah.org ; by telephone: 00 223 223 40 67. The web site www.insah.org contains full details of the registration process.

Questions/Comments and responses

Q1 Is there a difference between registration requirements for synthetic pesticides and biopesticides?

A1 The difference in registration procedures in chemicals and microbial biopesticides is large. The big difference is that the Tier structure is uniquely for biopesticides in order to reduce barriers to registration. Synthetic pesticides must supply an entire dossier. The tier system was not initially accepted by the CSP members. They wanted to look at international practice. Subsequently CSP developed twelve pages of biopesticide instructions. The guidelines for synthetic pesticides are perhaps three times that of biopesticides.

Q2 Regarding efficacy data, is it possible that LT_{50} data are sufficient for efficacy requirements.

A2 Details of the registration data requirements are available by contacting CSP, directly or on the web. Regarding biological efficacy, this should conform to the standards of

Protocol 4. But other protocols can be used, such as that of FAO. The experimental methods must be well described.

Q3 The costs of registration seem to be a barrier. Can you tell us how much a CILSS registration costs?

A3 The fee for a new registration is CFA Francs 500 000 (approximately $US1000). This is a very low fee. To pass to provisional authorization to sell (PSA), one must send an environmental dossier. CERES-Locustox is there to do this work. CSP developed a decision support system for making good decisions.

Q4 Have you reviewed the dossier of phenylacetonitrile (PAN)?

A4 We have not received a dossier for PAN. It should be noted that ecotoxicology tests for a registration dossier must be done in a CILSS member country and our definition of a biopesticide agent.

Q5 After 2007, what will happen to the registration of Green Muscle?

A5 CSP establishes a list of authorized products. This list is distributed to ministries of agriculture. When an PSA is granted, as it was for Green Muscle®, it is valid for three years with one opportunity for three-year renewal. If the Green Muscle® registration is not submitted by June 2007, the name will be dropped from the list.

Q6 With respect to the upcoming deadline, is it possible that Green Muscle® could be granted a special exemption as it awaits final registration?

A6 There is no flexibility in the document signed by the nine Member Countries to grant exceptions. There are currently no exceptions to the system. During the three years of an PSA, the dossier holder should be preparing the full dossier.

Q7 CSP represents many countries and makes great efforts on their behalf, but the resources are strained. Are the resources and member experience adequate to make good evaluations compared to international standards?

A7 CSP is composed of experts from the Sahel, among them professors. Each country has been asked to provide specialists. For example, Mauritania contributes an expert on locust management. There are two subcommittees: environment and ecotoxicology.

Q8 Does the CSP allow the secretariat to provide support to an applicant preparing a dossier?

A8 We are going to change the procedure for how the Secretariat is used so that we will be able to guide those submitting dossiers.

*Q9 Producers have an untenable situation. They have had to submit a registration to CILSS but must use a different name because another company has a provisional sale authorization (*PSA*) under the name Green Muscle. At great cost, we translated the dossier into French. Can such problems be sorted out in the future?*

A9 Regarding the product names for registration and the problem, this posed to a producer. A product must have a name. The registration guidelines did not anticipate that a second dossier might be submitted using the same name, as has occurred for Green Muscle®. It is preferable to give the second dossier another name. It is not obligatory to submit the registration dossier in French; English is acceptable. The name was the problem, not the translation of the dossier. We are not happy that Green Muscle® has been registered since 2001 and none sold.

Action plan

Participants met in parallel session for two and a half days to develop work plans aimed at removing scientific, regulatory, supply, training and promotional constraints to integrating biopesticides into operational campaigns. Each group developed a two year plan of action, which was discussed in a brief plenary session.

The consolidated Action Plan for March 2007 to February 2009, amended to remove duplication, follows at Annex 1.

Annex I **ACTION PLAN: the future of biopesticides in Desert Locust Management**

Main objective: Biopesticides are used more widely in Desert Locust control
Specific objective: Appropriate strategies are defined and implemented

Classification: Priority 1, Priority 2, Priority 3 refer to the relative weight each activity contributes to achieving the main objective.
Timing refers to three month periods (1-8) from March 2007 to February 2009 and indicates the order of programme activities and sub-activities

Results	Activities	Indicators	Timing	Responsibilities	Costs/ resources	Priority and remarks
I: RESEARCH AND DEVELOPMENT						
R1. The efficacy of *Metarhizium* is improved, target populations are well defined and the conditions for application are known.	**A1. Define target population and zones:** (1) Map ecologically sensitive areas (2) Define the role of *Metarhizium* in preventive and curative control. (3) Compare the efficacy of strategies using biopesticides and synthetic insecticides.	(1) 50% of sensitive areas mapped (2,3) Study reports available	(1) 1-5 (2) 1 (3) 1	(1) FAO, WB AGRHYMET, (2, 3) FAO, CLCPRO, CRC, EMPRES	(1) Consultancy firms in countries concerned. (2,3) Consultant(s)	**Priority 2** (1) Indicator percentage: time needed for mapping difficult to estimate
	A2. Verify efficacy under operational conditions: (1) Establish a harmonized method for efficacy testing. (2) Constitute multi-organizational teams to carry out field trials. (3) Carry out efficacy trials with *Metarhizium* under field conditions (focusing on the effect on mobility of and feeding by the hoppers)	(1) Protocol available (2) List of resource persons made (3) Reports of 4 trials available (2 trials/year)	(1) 1 (2) 1 (3) 1-6	(1) FAO, (2) CLCPRO, CRC, EMPRES (3) FAO, CLCPRO, CRC, EMPRES, AGRHYMET, National Locust Control Units.	(1) Consultant	**Priority 1** (3) Contribution of complementary projects (3) Activity to continue after this programme. (3) Locust availability will determine number of trials. (3) Rapid implementation essential when favourable field situations arise.

Results	Activities	Indicators	Timing	Responsibilities	Costs/ resources	Priority and remarks
R1 continued *The efficacy of* Metarhizium *is improved, target populations are well defined and the conditions for application are known.*	**A3. Improve the efficacy of *Metarhizium* by combination with PAN:** (1) Study the effect of PAN on thermoregulation and immune response to *Metarhizium*. (2) Carry out trials with fractional doses *Metarhizium* + PAN to establish the lowest dose of *Metarhizium* and PAN needed for complete control, including the effect on band mobility.	(1) Trial reports available (2) Reports of 10 cage trials available (2) Reports f 2 field trials available	(1) 5 (2) 1-6	(1) FAO, ICIPE (2) FAO, ICIPE, CLCPRO, CRC, EMPRES, AGRHYMET, National Locust Control Units.		**Priority 2** (2) Combine field trials with those planned in A2 when feasible (2) see also remarks at A2
	A4. Improve the formulation and its shelf-life (1) Produce a formulation with minimum sedimentation and easy re-suspension (2) Adapt the formulation to storage conditions at ambient temperatures. (3) Improve packaging with respect to size (trials vs. operations) and disposal. (4) Study potential techniques to protect spores against the effect of UV radiation after treatment.	(1, 2, 4) Improved formulation available (3) Improved packaging available	1-4	Manufacturer(s) of *Metarhizium*, National Locust Control Units.		**Priority 1** This section contains all activities for testing and validating new formulations. Screening in laboratory or *bomas* [i.e. arenas]

Results	Activities	Indicators	Timing	Responsibilities	Costs/ resources	Priority and remarks
R1 continued *The efficacy of* Metarhizium *is improved, target populations are well defined and the conditions for application are known*.	**A5. Identify the effects of different environmental parameters (biological and non-biological) on the efficacy of *Metarhizium*.** (1) Study the effect of UV and temperature (low/high) on the efficacy of *Metarhizium*. (2) Determine the periods in the year and times of application during the day when treatments are most effective. (3) Study the effect of vegetation density and structure on *Metarhizium* efficacy. (4) Study the effect of *Metarhizium* on predation activity (natural enemies) and on cannibalism. (5) Develop a model to predict median lethal times as a function of environmental parameters (6) Map areas and times of optimal efficacy as a function of temperature.	(1-4) Study reports available. (5) Model available and easy to use (6) Maps available.	(1) 1-4 (2) 5-7 (3) 1-7 (4) 1-7 (5) 4 (6) 6	(1-4) ICIPE, AGRHYMET, National Locust Control Units. (5,6) FAO	(5,6) Consultant	**Priority 2** (1-4) Parameters should also be included in field trials under R1, A2 & A3) (4) Important natural locust population required. (1-6) First phase will always be a laboratory or desk study or a small-scale field trial
R2. Environmental risks of *Metarhizium* and PAN in Desert Locust countries are evaluated for registration purposes	**A1. Review all environmental and human health studies on *Metarhizium* and PAN** in order to indicate species at risk, and to identify complementary studies or tests needed to fulfil registration requirements	Review available.	1	FAO, CILSS/CSP, Registration Authorities in the countries concerned	Consultant	**Priority 3**
	A2. For PAN (1) Review environmental risk (2) Carry out ecotoxicological tests	Review and test results available	(1) 1 (2) 2-3			

Results	Activities	Indicators	Timing	Responsibilities	Costs/ resources	Priority and remarks
R2. contnued Environmental risks of Metarhizium and PAN in Desert Locust countries are evaluated for registration purposes	**A3. Strengthen capacity in risk assessment of biopesticides** for registration purposes in those countries requesting assistance.	At least one specialist in risk assessment of biopesticides in all countries	4-8	FAO, registration authorities requesting this	Consultant	**Priority 3** Countries requiring assistance unknown CILSS-CSP to be included in capacity building
	A4. Carry out environmental monitoring treatments of organisms identified under R2A1 as being potentially at risk. (1) Establish an environmental monitoring protocol (2) Validate the environmental monitoring protocol (3) Monitor treatments	(1) Protocol available (2) Protocol validated (3) Monitoring reports available	(1) 3 (2) 4-7 (3) 4-7	FAO, EMPRES, QUEST teams, National Locust Control Units.	(1) Consultant (2) Validation costs	**Priority 3**

Notes: Research and Development R1 A4 may change formulation specifications. The information and coordination objectives (R3, R4) are now Section III: R8, R9

II: AVAILABILITY AND QUALITY OF BIOPESTICIDES						
R3. Biopesticides available in sufficient quantities upon demand and on time	**A1. Establish timely demand forecasting for biopesticides** (including required stock levels)	Study on pesticide demand forecasting for desert locusts within Africa completed	1-2	FAO (consultant)	local consultants (30 days per country) 1 modeller for 3 months	
		Functioning model being used	4-8	FAO and stakeholders		
	A2. Improve existing GIS-based locust forecasting methods (SWARMS, eLocust2, RAMSES)	Comparative study of major models completed	1-2	FAO	As for A1	
		Pesticide demand forecast for desert locust control issued	3 7	FAO		
		Locust forecasting bulletin is regularly available and transmitted in real time	3 7	FAO		

Results	Activities	Indicators	Timing	Responsibilities	Costs/ resources	Priority and remarks
R3. continued Biopesticides available in sufficient quantities upon demand and on time	**A3. Create national storage and formulation facilities**	Storage facilities functioning in at least 50% of priority locations	1-6	Countries		
	(1) Determine location of national and regional storage facilities	List of locations	1	FAO, countries	local consultants (10 days per country)	
	(2) Design a management system for national storage facilities	Manual of management practices for storage facilities	2	FAO	International consultancy 90 days	
	(3) Establish a quality monitoring system for storage facilities	Report on quality monitoring	7	Countries	7 days/country	
	A4. Define and create "virtual" biopesticide banks	Contracts signed	2	FAO, industry		
	A 5. Improve supply capacity	Subcontracting clause included in all licenses	1	CABI	Minor cost	licensee subcontracts or other arrangements among licensees needed
	A 6. Streamline bidding process	Report on steps taken to streamline bidding process	2	FAO, national governments	External funding	Consider pre-purchase contracts
	A 7. Agree on standard funding for biopesticides procurement	Special funds for biopesticide procurement available. At least 15% of pesticide budget for biopesticide purchase	3	DLCC		
R4. Biopesticide quality meets specifications from sale until use	**A1 Refine product specifications in licensing agreements**	A document with new specifications and standards for licensing agreement available	2	CABI	International consultant (15 days)	
		Standard operation procedures and technical operating procedures available for the new licensing agreement	2	CABI	International consultant (15 days)	
	A2 Establish accreditation and audit procedures for product production process	Manual of accreditation and audit procedures for the product production process	2	CABI	International consultant (30 days)	Operational by quarter 4 after adoption

Results	Activities	Indicators	Timing	Responsibilities	Costs/ resources	Priority and remarks
R4. continued Biopesticide quality meets specifications from sale until use	**A3 Promote standards for preserving post-sale quality of product**	Material Safety Data Sheet available and distributed with the product	2	BCP, SenBiotech	International consultant (10 days)	
	A4. Establish standards for post-sale monitoring of product quality	Manual for post-sale monitoring and assessing product quality	2	BCP, SenBiotech	International consultant (30 days)	
	A5. Solve transit problems (e.g. customs holding)	Report on information awareness for customs officers	3	FAO, recipient and transit countries	International consultant (10 days). Other organisational fees	Collaborate with Basel Convention
		List of registered biopesticides available to customs officers at ports of entry	2	Countries and Registration Authorities		
R5. Biopesticides are registered in the regions	**A1. Streamline legal requirements for Biopesticide registration**	The registration process does not exceed six months	2- 7	FAO, CSP Registration Authorities	International consultant 10 days.	Include regulatory bodies other than CILSS Prior work with the registration committee
	A2. Provide handbook of biopesticide registration procedures in the Western Region	Handbook available to national governments	6	CSP, national governments	Handbook costs	
	A3. Identify countries for which registration is advisable	List of countries	2-8	FAO		Countries in R1A1 studies
	A4. Strengthen capacity of CSP to handle dossiers	Risk assessment software operational	3-5	CSP, FAO	National consultant	
R6. All biopesticide producers are licensed	**A1. Establish streamlined licensing procedures to overcome existing constraints**	Standard licence agreement.	2	CABI, licensees	International consultant (5 days)	
	A2. Publish licensing procedures	Publication stating licensing procedures	3	CABI		

Results	Activities	Indicators	Timing	Responsibilities	Costs/ resources	Priority and remarks
R6. continued All biopesticide producers are licensed	**A3. Ensure contractual requirements of licenses are honoured**	Funds available to ensure requirements are honoured	2	FAO		
		Document recording the implementation of systems is available	2-8	CABI		
		Database of purchases and suppliers available	3	CABI, Licensees		
		Memorandum of Understanding between regulatory authorities and CABI regarding limiting registrations to licensed producers	2	CABI, Registration Authorities		
		Database of all registrations and registration holders available.	3	CABI, Registration Authorities		
	A4. Licence and make producers known, particularly to regulatory authorities	Database of names and addresses of relevant regulatory authorities, donors and other potential large-scale purchasers and users accessible	3	CABI		Suggest amalgamate R6 databases into a single database accessible by password on the web.
	A5. Revise LUBILOSA Trust	Revised LUBILOSA Trust agreement	3	CABI, SDC, DFID, DGIS	10 days	
	A6. Identify funding for R6	Licence and Trust amendments funded	1	FAO CABI		
R7. Stewardship of best practices documented in full and implemented	**A1. Establish an electronic User Manual of best practices for locust biopesticides**	Manual available on web Best practices observed in campaign evaluations	1	Licensees		Ensure links to locust information web-sites Use in training Locust Spray Teams
	A2. Publish biopesticide handling and disposal manual based on manufacturers advice		1	Licensees		
	A3 Flyers, brochures and technical information available in appropriate languages		1	Licensees		

Note Research and Development Result 1 Activity 4 may change formulation specifications.

Results	Activities	Indicators	Timing	Responsibilities	Costs/ resources	Priority and remarks
III. INFORMATION, COORDINATION, TRAINING AND PROMOTION						
R8. Scientists and locust officers have rapid access to suitably focused information on the internet and in other appropriate formats	**A1. Publish and disseminate a biopesticide research and development information bulletin in French and in English**	3 bulletins disseminated (1 per semester)	2-8	EMPRES	Consultant/ translator	Use other organizations as dissemination points (e.g. AGRHYMET)
	A2. Disseminate research and development results in refereed journals		2-8	Programme staff		
	A3. Publish biopesticide trial reports		3-8	FAO		
	A4. Create and maintain a web-site for: web-based training; technical, application and research aspects of biological control including publications, reports and databases of experts;	Hub-web site open and regularly updated with links to all relevant web pages, partners and other organizations	3-8	FAO		**Priority 3** Multilingual versions required to access wide audience (English, French and Arabic priorities)
R9. The research and development programme is well coordinated nationally, regionally and internationally	**A1. Encourage informal as well as formal contacts between national, regional and international programme partners**	Programme partners are satisfied (questionnaires)	3-7	FAO, CLCPRO, CRC, EMPRES		**Priority 3**
	A2. Organize planning meetings	1 meeting per year	1, 5	FAO, CLCPRO, CRC, EMPRES		**Priority 3** Telephone conferences and other periodic exchanges.
	A3. Monitor and evaluate programme activities.	Progress reports available	2-8	FAO Evaluation Service	Country visits Consultant	**Priority 3**
	A4. Organise a workshop on programme results and plan Phase II	Adoption of Phase II plan	3	FAO		Hold IFAD Steering Committee Meeting, in relation to A2 planning meeting

Results	Activities	Indicators	Timing	Responsibilities	Costs/ resources	Priority and remarks
R9. continued *R&D programme well coordinated*	**A5. Organise a workshop to evaluate progress with biopesticides and discuss possibilities for consolidation and operational use**	Workshop held on evaluating progress with biopesticides	8	All stakeholders		
R10. National policy- makers are well informed and integrate biopesticides into Desert Locust management	**A1. Establish permanent contacts for information and briefing documents**	System for information exchange and briefing operating at all appropriate levels of government	permanent	EMPRES Liaison Officers and Plant Protection Services	Countries	**Priority 1** Appropriate communication strategy needed
	A2. Ensure Governments commit to integrating *Metarhizium* into their locust management strategy	Pest control programmes with biopesticides are adopted and implemented by Green teams	5, permanent	Senior Managers of CNLAA/Plant Protection Services		Implementing strategy defined at R1 A1(2)
R11. The DLCC recommends adoption of biopesticides in Desert Locust management	**A1. Ensure the value of integrating biopesticides in locust control raised at Meetings of DLCC and the Commissions**	Presentation to the Council of Ministers, DLCC and other key meetings	1-8 permanent	All stakeholders		**Priority 1**
R12 Spray teams trained in best practices for operational use of biopesticides	**A1. Develop and implement training programme**	Training curriculum available	1	FAO		**Priority 1**
	A2. Add biopesticide section(s) to the Train the Trainers Manual for Desert Locust Control (en, fr)	Revised manual on the use of biopesticides available	2	FAO		Revalidate manual after a train the trainers session
	A3. Order necessary equipment	Equipment available	2	FAO		
	A4. Validate the biopesticide modules of the training programme	Three-day meeting endorses training programme	2	FAO, countries		Meeting for key training experts representing FAO and countries)
	A5. Conduct regional master trainers workshops	One training session lasting at least 10 days conducted	3	FAO, countries		Practical training essential
	A6. Conduct national training session for biopesticide spray teams	At least one *Green team* operational	5	FAO, countries		Evaluate and support master trainers

Results	Activities	Indicators	Timing	Responsibilities	Costs/ resources	Priority and remarks
R13. Civil society, media and farmers committed to biopesticides	**A1. Develop a publicity plan**	Regional action plan developed				If none exists
	A2. Carry out a publicity and information campaign	Publicity campaign held in 3 countries				Confidence in biological locust control
	(1) Produce posters, leaflets for farmers and NGOs	Posters produced in 6 languages (5000 copies)	4-8	CNLA, NGOs		Publicity material in (3-6) languages (e.g. Arabic, French, Poula, Wolof, Bambara, Soninke)
	(2) Produce national and regional television clips and radio broadcasts for farmers	Media involved in each country	5, 6	CNLA, NGOs, FAO		If current plan exists
	(3) Stage national awareness sessions for farmers, NGOs and the media	1 session held per country	6-8	CNLA, NGOs, FAO		3 pilot countries
	(4) Hold press conference	1 conference held per country	8	CNLA, other		3 pilot countries
	(5) Initiate study tours for the media and NGOs	1 tour for both NGOs and media conducted	8	CNLA, NGOs		Timed to coincide with an especially successful activity
	A3. Train NGOs in advocacy (1) Plan and conduct training courses in advocacy	1 regional training for 20 people	8	NGOs, PAN Africa		Dakar

Annex II List of participants

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